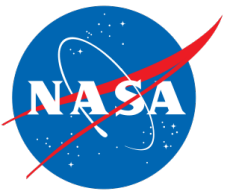


# Understanding the Details of the MODIS Aerosol Product

TCEQ Training Course  
February 24 – 27, 2014

**ARSET** - The NASA **A**ppplied **R**emote **SE**nsing **T**raining  
Program



# **MODIS products are divided into three main categories**



**Atmosphere**

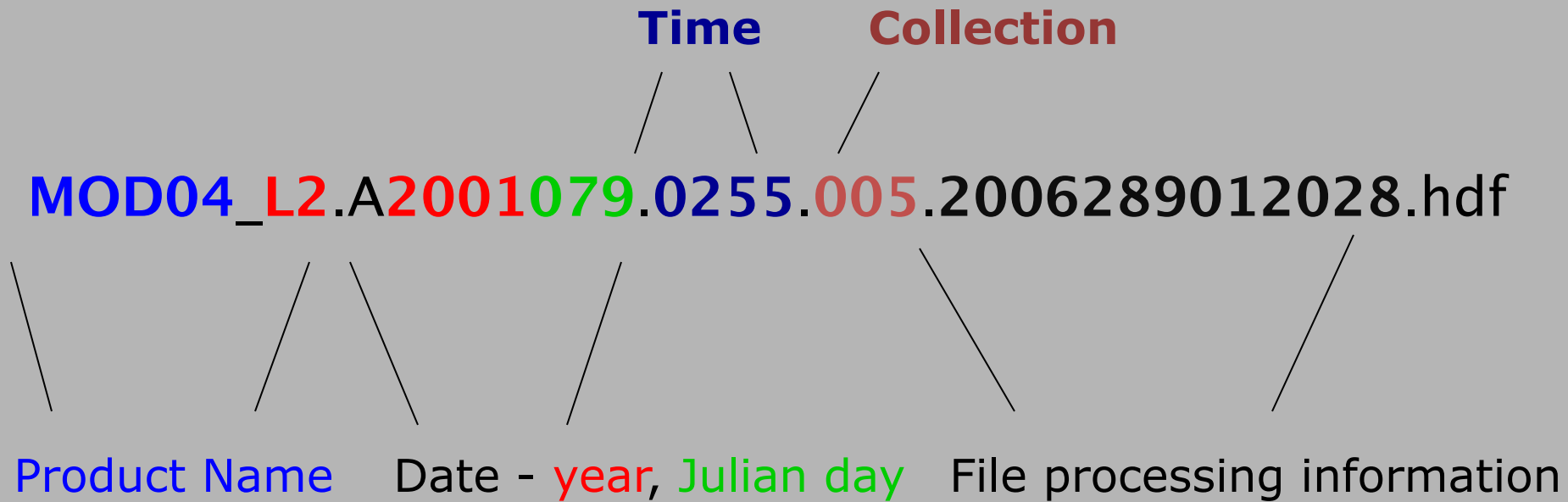
The diagram consists of three horizontal blue rounded rectangles, each containing a category name. Each rectangle is connected to a thin blue line that extends to the right, suggesting a continuation of the list or a connection to further details.

**Land**

**Ocean**

Due to the size and variety of products there is no single source for information about the MODIS products.

# Understanding a MODIS File Name



# Data Levels

Level 1 Products – Raw data with and without applied calibration.

Level 2 Products – Geophysical Products  
(sometimes gridded)

Level 3 Products – Globally gridded geophysical products

**This structure is common to many satellite products**

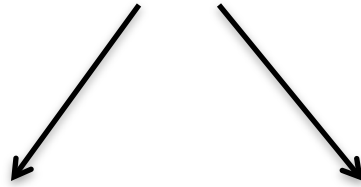
# Fundamental Inputs

- **Calibrated and Geolocated Reflectances (MOD02, MOD03, Errors <2%)**
- **Surface Information (land, water, desert)**
- **Meteorological Data from NCEP**
- **Other Ancillary data sets**

# MODIS Aerosol Products

## Three Separate Algorithms

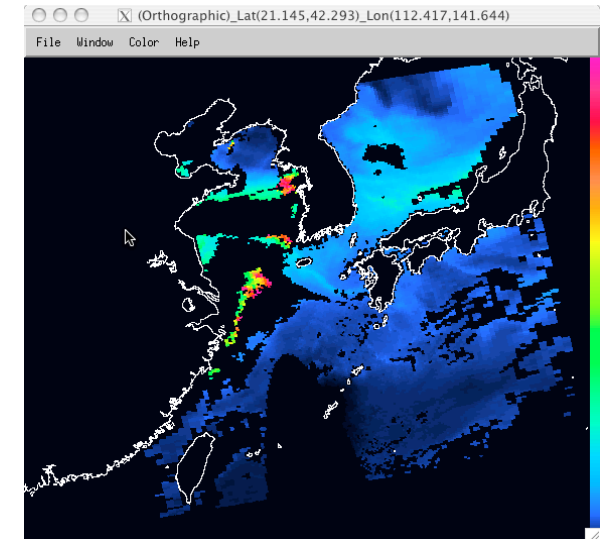
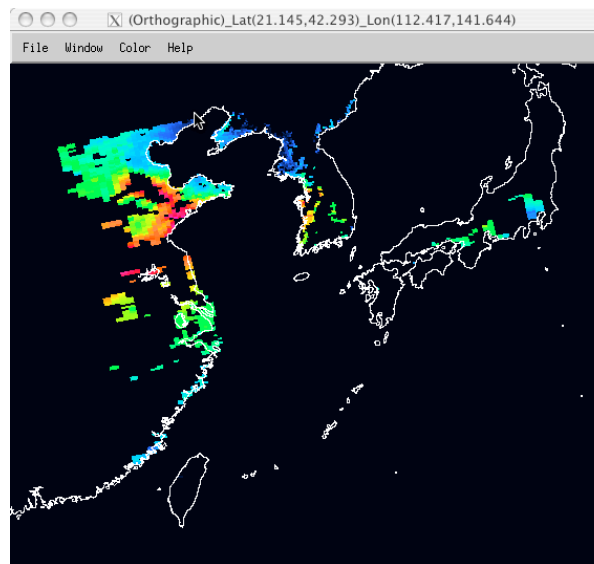
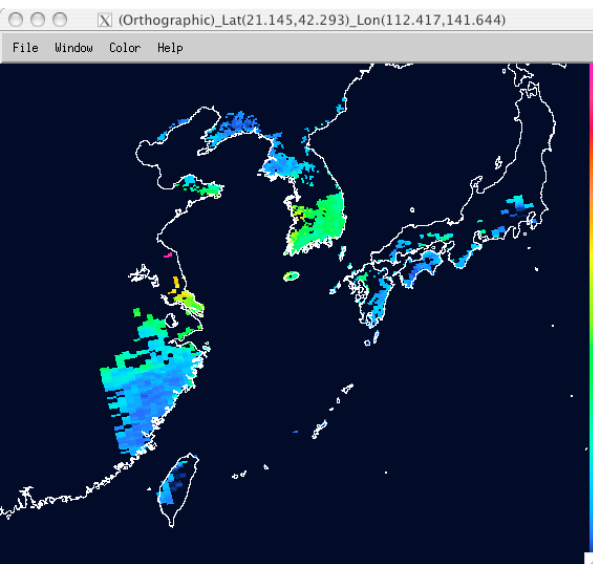
Land



Dark Target

Deep Blue

Ocean

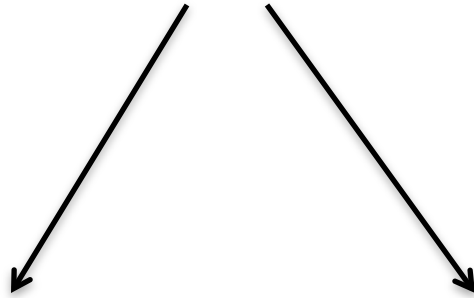


# MODIS Aerosol Products

## Three Separate Algorithms

**Land**

**Ocean**



Detailed presentation on the MODIS ocean algorithm available at <http://ARSET.gsfc.nasa.gov/materials>

Dark Target

Deep Blue – Used over bright land surfaces

Currently the dark target and deep blue products are separate. When both are available the user must select which one to use

In collection 6 there is a joint product that uses an automated procedure to select the appropriate input for land

# MODIS Aerosol Products

All three algorithms create a **10 Km product**.

Land and Ocean      400 half kilometer pixels.

Deep Blue              100 one kilometer pixels

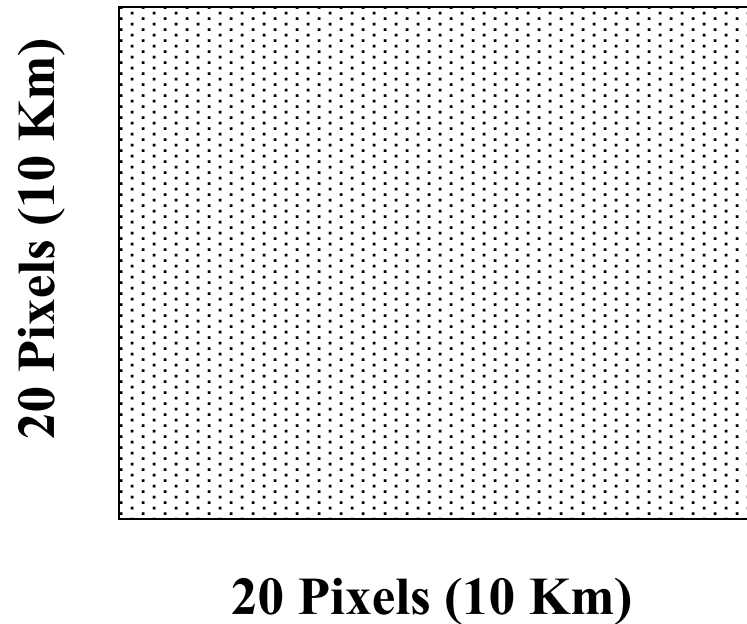
Ocean and Land (dark target) algorithms  
assume that aerosols brighten the scene.

Retrievals can only occur where there are a  
sufficient number of spectrally dark pixels.



# Dark Target Land Algorithm...

- **First Step: Organize reflectance in three channels (0.47, 0.67, and 2.13) into 10X10 Km box (20X20 =400 Pixels) at 500 m resolution**



# MODIS Aerosol Products

## Important Points to Remember for MODIS Aerosol Products

- **Ocean** and **Land** Products are produced using totally separate and distinct algorithms. All current Level 2 aerosol products are at 10 Km (10 x 10) resolution.
- The most important products for air quality are **Aerosol Optical Depth** and **Fine Fraction**. These exist for both **Ocean** and **Land**.
- **Fine Fraction** over land should be seen as a **qualitative** indicator not as a quantitative measurement.  
It is not included in collection 6

# MODIS Aerosol SDS

The **Ocean** and **Land** algorithms each produce their own Scientific Data Sets or SDS' s. When both algorithms retrieve the same parameter they may be combined into a joint **Land\_and\_Ocean** SDS.

The individual **Land** or **Ocean** SDS is generally preferred because

- it contains more wavelengths
- gives more information about quality
- at level 3 it gives a quality weighted product that screens out anomalies

**Land\_And\_Ocean** Is useful if you need both together but may not give the same results as **Land** or **Ocean**

# Aerosol Products

Main Products - Land

Corrected\_Optical\_Depth\_Land  
Retrieved AOD at .47, .55, and .66

 AOD

Optical\_Depth\_Ratio\_Small\_Land  
Fraction of Fine Mode Aerosol  
Not reported for AOD < 0.2

 Fine  
Fraction

Optical\_Depth\_Small\_Land  
AOD \* Fine Mode Ratio  
(may be a threshold)

 Fine  
AOD

# Aerosol Products

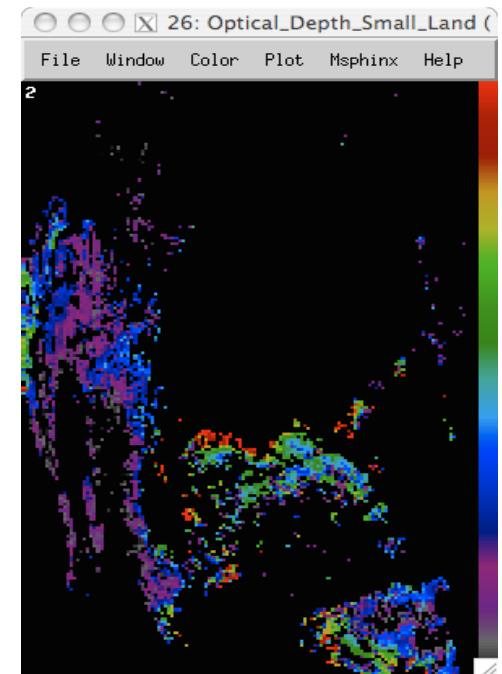
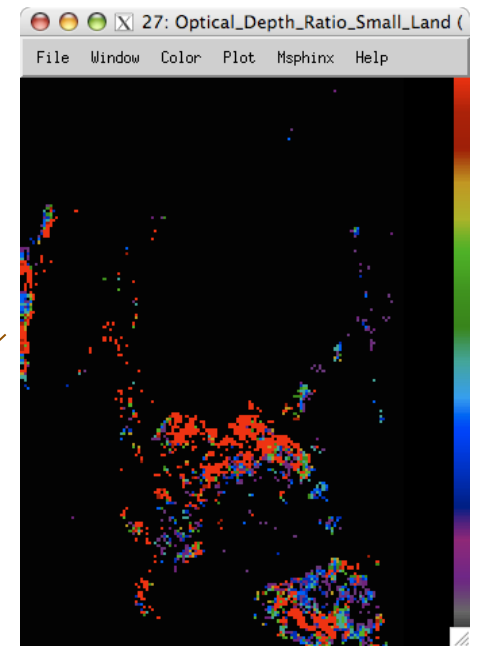
## Main Products - Land

Corrected\_Optical\_Depth\_Land  
Retrieved AOD at .47, .55, and .66

Optical\_Depth\_Ratio\_Small\_Land  
Fraction of Fine Mode Aerosol  
Not reported for AOD < 0.2

Optical\_Depth\_Small\_Land  
AOD \* Fine Mode Ratio  
(may be a threshold)

**A Qualitative Product Only!**



# MOD04 Aerosol Products

MYD04

## Main Products - Ocean

Effective\_Optical\_Depth\_Average\_Ocean  
Retrieved AOD at .47, .55, .66, .86, 1.24,  
**1.63**, 2.13



AOD

Optical\_Depth\_Ratio\_Small\_Ocean\_0.55\*  
Fraction of Fine Mode AOD at 0.55



Fine  
Fraction

Optical\_Depth\_Small\_Average\_Ocean  
AOD \* Fine Mode Ratio



Fine  
AOD

# Quality Assurance is Extremely Important!!

QA indicates the confidence in the quality of the retrieval.

Quality\_Assurance\_Ocean  
Scale is 0 - 3

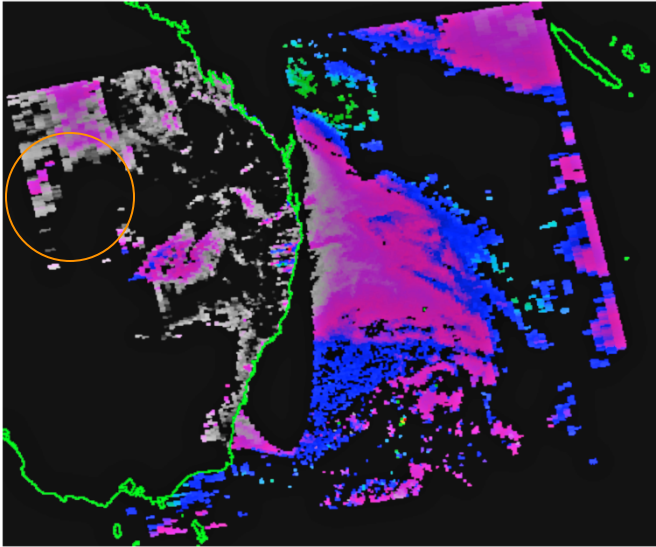
Recommend Ocean QA above  
0

Factors:  
Number of pixels  
Error fitting  
How close to glint

Quality\_Assurance\_Land  
Scale is 0 - 3

Recommend Land QA of 3

Factors:  
Number of pixels  
Error fitting  
Surface reflectance

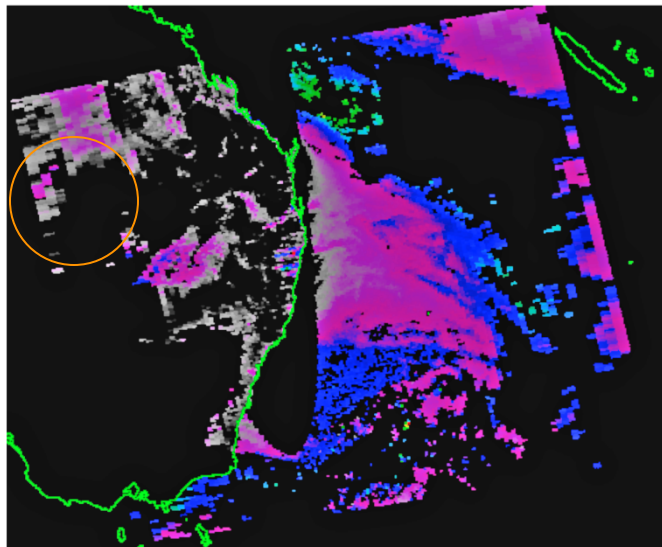


Image\_Optical\_Depth\_Land  
\_and\_Ocean

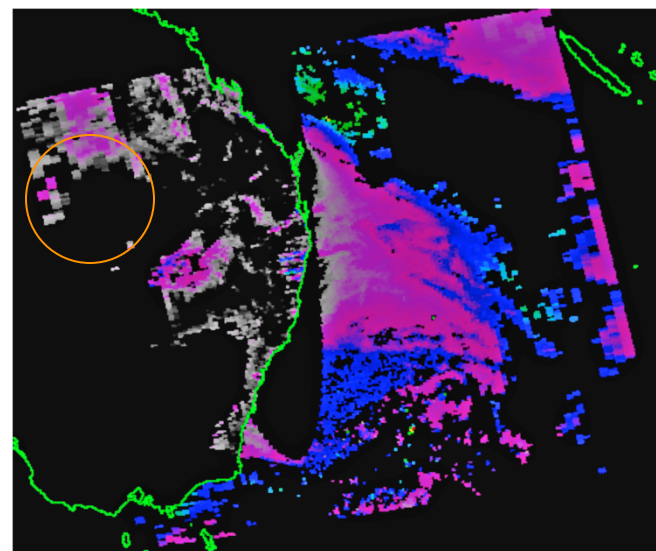
For Visualization purposes when you want an image of as much of the scene as possible.

This SDS includes poor quality (QA level 0) data

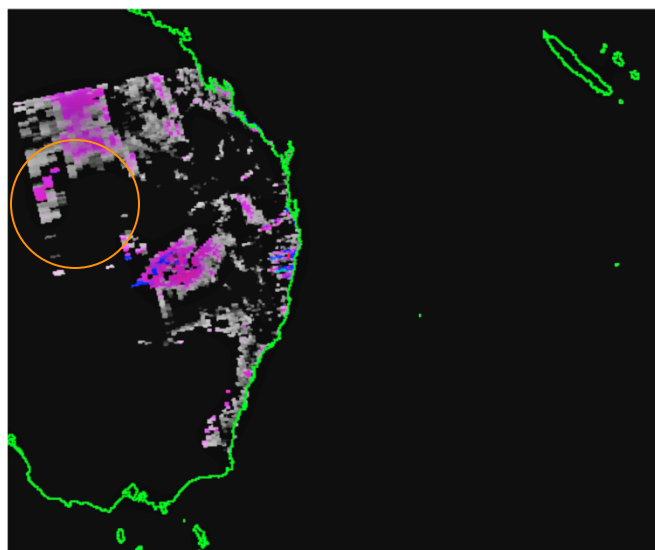




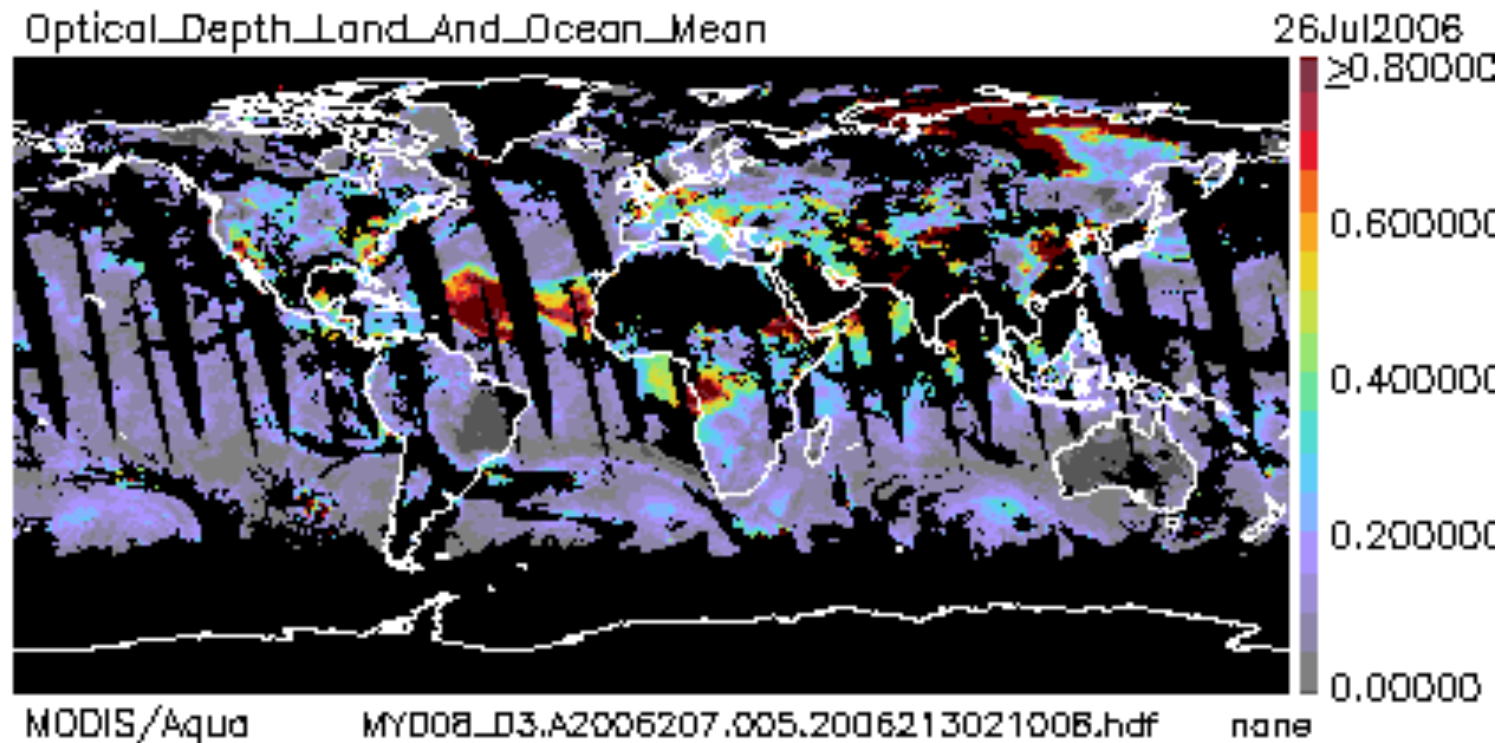
Image\_Optical\_Depth\_Land  
\_and\_Ocean



Optical\_Depth\_Land\_and\_Ocean



Corrected\_Optical\_Depth\_Land



Daily L3 aerosol optical thickness over land and ocean

The large gaps over ocean are due to **Sun glint**

The gaps over land are due to **bright surfaces** and **and clouds**

Regularly spaced gaps near the equator are due to lack of **coverage between orbits**.

# Formatting of MODIS and many other NASA products

**MOD - Terra product**

**MYD - Aqua product**

All MODIS products come in **HDF** format.

In HDF format each file contains both data and metadata

**SDS** - Each parameter within a MODIS HDF file is referred to as an SDS

(Scientific Data Set)

An SDS must be referenced precisely according to name when analyzing the data with your own computer code.

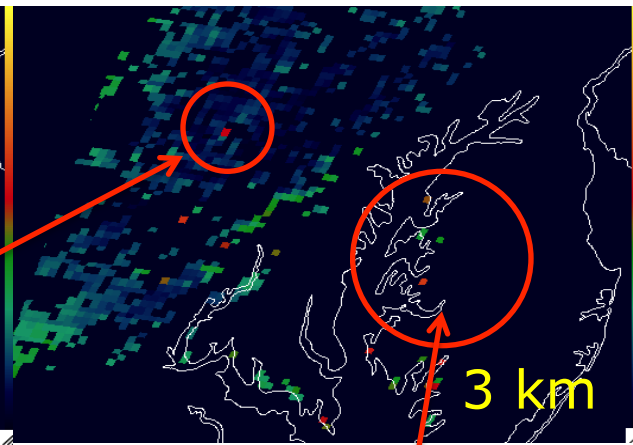
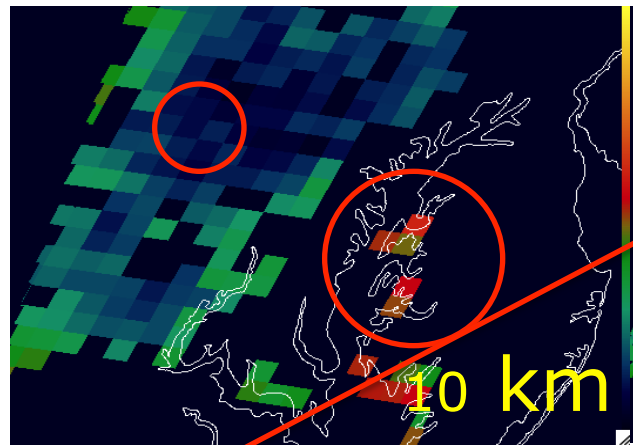
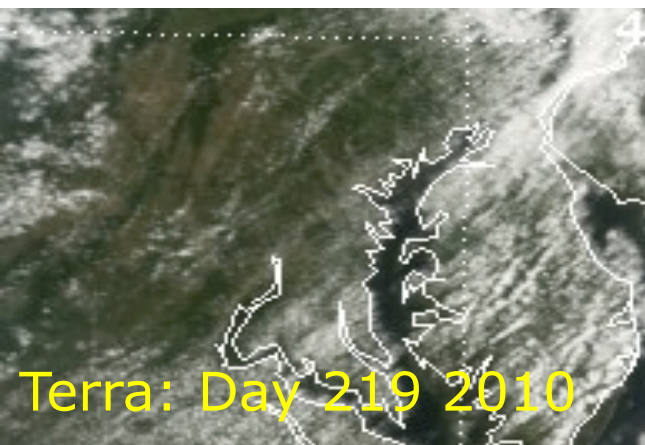
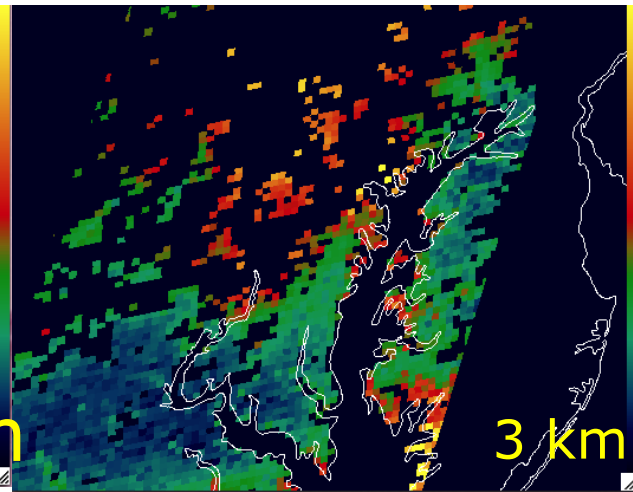
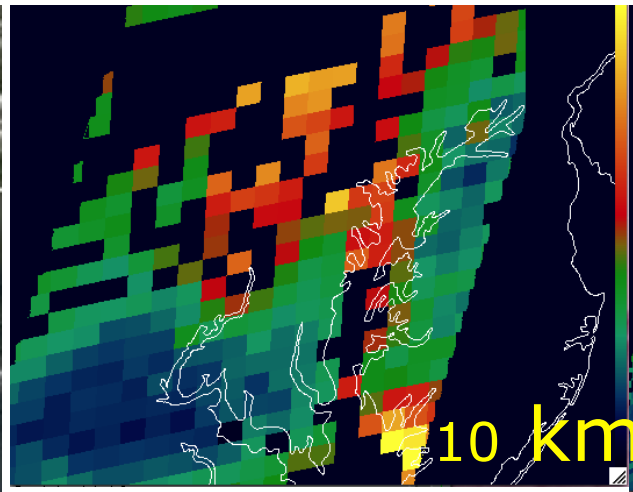
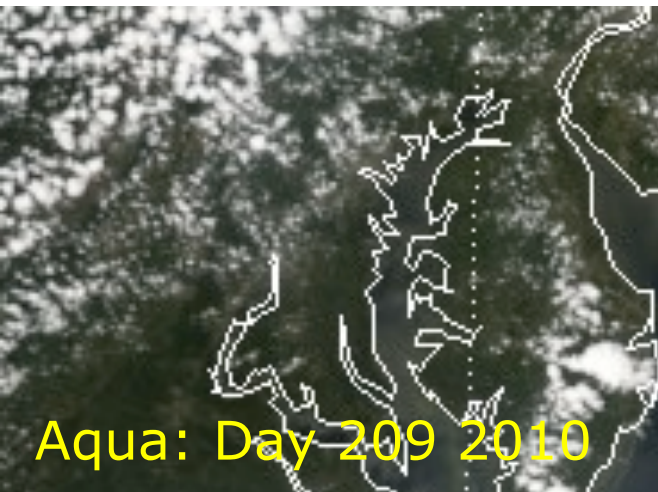
# MODIS 3 km product (operational for C006)

## Aqua processing to begin soon

- Algorithm nearly identical to standard “10 km” MODIS retrieval
- Results will be in new files, ***‘MOD04\_3K’***
- Both MOD04\_L2 and MOD04\_3K will be available

S. Mattoo, L. Munchak, M. Martins, L. Remer, B. Holben, et al

# MODIS 3 km product over suburban (MD) landscape (summer 2010)



- 3 km mirrors 10 km product (pattern and magnitude)
- 3 km introduces **noise**, but also can reduce spatial impact of **outliers**

# MODIS 3 km product compares with AERONET (DRAGON-2010)

Multiple AERONET sites in Maryland

station	AERONET	MODIS 3 km	MODIS 10km
BLTIM	0.29	0.28	0.17
LAUMD	0.26	0.24	0.20
OLNES	0.23	0.22	0.09
RCKMD	0.25	0.33	0.19

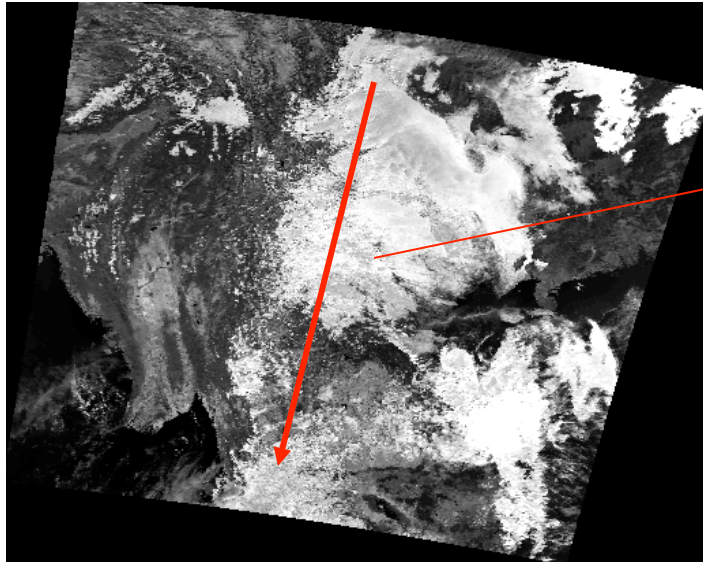
- Overall, 3 km mirrors 10 km “validation”.
- 3 km validation sometimes improves with higher resolution matching

# MODIS “Deep Blue”

- The standard MODIS aerosol LAND algorithm relies on finding dark targets. For this reason it is unable to make retrievals over bright surfaces such as deserts.
- Deep Blue relies on the blue wavelengths and libraries of surface reflectance to make retrievals in these areas.
- Deep Blue SDS Names:
  - Deep\_Blue\_Aerosol\_Optical\_Depth\_550\_Land
  - Deep\_Blue\_Aerosol\_Optical\_Depth\_Land
  - Deep\_Blue\_Angstrom\_Exponent\_Land
  - Deep\_Blue\_Single\_Scattering\_Albedo\_Land
  - Deep\_Blue\_Surface\_Reflectance\_Land

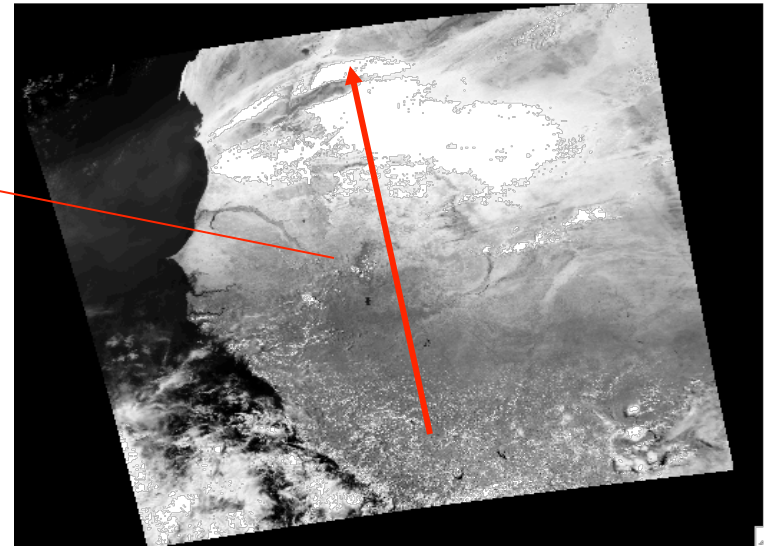


Terra Reprojected  
Granule: 30 Local Time



Flight  
Direction  
of the  
Overpass  
Gives a  
“Tilt” to  
the  
reproject  
ed  
granule

AQUA Reprojected  
Granule: 30 Local Time



**ALWAYS CHECK YOUR DATA VISUALLY!**



Time 0 Min



Time 5 Min

